XIII. *A Letter from Mr.* Benjamin Wilſon, *F. R. S. to the Rev.* Tho. Birch, *D. D. Secret. R. S.*

Dear Sir,

Read Mar. 22, 1759. THE incloſed letter contains ſome electrical experiments and obſervations, which ſeem to merit the attention of the Royal Society. I wiſh therefore you would lay it before them; and at the ſame time ſignify, that I have ſeen all the experiments carefully made, and that the ſeveral facts therein contained are faithfully related. I am,

SIR,

Your moſt obedient humble Servant,

Queen-ſtreet, London, 22 March, 1759. B. Wilſon.

A Letter from Edward Delaval, *M. A. and Fellow of* Pembroke-Hall, Cambridge, *to Mr.* Benjamin Wilſon, *F. R. S. containing ſome Electrical Experiments and Obſervations.*

SIR,

Read Mar. 22, 1759. I Send you a few electrical experiments and obſervations; and deſire your opinion, how well they eſtabliſh a convertibility, I believe hitherto unnoticed in many ſubſtances, from conductors into non-conductors of the electric fluid.

I have filled ſeveral ſmall glaſs tubes with the dry powders of calcined metals, *viz.* ceruſs, lead aſhes, minium, calx of antimony, *&c.* Into each end of every tube I put a piece of iron wire, which communicated with the calx, and faſtened them with wax: ſo that the electric fluid, not being able to eſcape by means of the glaſs, muſt either paſs thro' the calx, or not at all. Upon hanging one of the wires, bent for the purpoſe, to the electrified bar, and holding the other in my hand, I obſerved that no electric matter did paſs the calx, the ſnaps iſſuing all the while from the bar, or from that wire which was in contact with the bar *.

Animal and vegetable ſolids alſo, when reduced to aſhes, and interpoſed in the ſame manner between two pieces of wire, do, I find, as effectually intercept the electric ſtream, as the metallic calces.

From theſe experiments you ſee, that animal, vegetable, and metallic bodies, tho' ſuch known conductors of the electric fluid while in their intire ſtate, are eaſily changed into reſiſters or non-conductors of it.

I was led to attempt this change from its having been obſerved, that dry mould would not conduct the electric fluid: and from thence I ſuſpected, that one claſs of the non-conductors muſt owe its property to an electrical virtue that would be found to reſide in the calx, or earth of the chymiſts, after it is diveſted of the unctuous inflammable matter, which

* Since I wrote this letter, I have been informed, that part of this firſt experiment, relating to metallic calces, has been made before by Dr. Watſon. See the note Phil. Tranſ. vol. xlv. p. 107.

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conſtitutes another of the chymical principles called ſulphur; in like manner as this ſulphur is conſtantly found highly electrical in all bodies where it abounds in a ſolid form, *viz.* reſins, wax, *&c.*

Theſe experiments appear to verify my ſuppoſition: for all the above-mentioned ſubſtances, which were thus changed into non-conductors, conſiſt either wholly, or in a great meaſure, of earth freed from the unctuous inflammable particles; the metals not being calcineable without a degree of heat that muſt diſſipate all their ſulphur, as is evident from their not being reducible again into their metallic form without the admixture of ſome unctuous matter; and the ſame diſſipation of their ſulphur muſt take place in the animal and vegetable ſubſtances, before they become white aſhes.

I ſhall not at preſent attempt an account, why bodies conſiſting of either of theſe ſubſtances ſeparately are electric, tho' it appears to me deducible from ſome doctrines of Sir Iſaac Newton; but only propoſe a thought concerning the reaſon why theſe two principles, calx and ſulphur, which are known to unite in the compoſition of almoſt all bodies, ſhould, notwithſtanding they are electric when ſeparate from each other, be yet found non-electric when united in one body.

It muſt be remembred, that there is a remarkable and well-known oppoſition in the electrical effects of theſe two claſſes; the earthy one (as glaſs and ſtones) electrifying *plus*, and the ſulphureous one *minus*. Does it not ſeem then a thing to be expected, in a body compounded of both, that the oppoſite powers of theſe ingredients ſhould counterballance

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and deſtroy the effects of each other, and the body in which the poſitive and negative ones equally prevail, become neutral, or non-electric?

I have not ſcrupled to rank thoſe known poſitive electrics, glaſs and tranſparent ſtones, under that claſs of bodies which conſiſts of calx or earth; becauſe all vitrifications muſt proceed from previous calcinations, and all calces may be vitrified in the focus of large burning-glaſſes. The tranſparent ſtones alſo conſiſt of little more than pure earth, free of the leaſt mixture of oil, if we may judge of others by the chymical reſolution of cryſtal.

There is another proceſs, natural and without fire, which is ſuppoſed to deſtroy the ſulphureous ſubſtance of metals, *viz.* when they are corroded, and moulder in the open air. Accordingly, with the ſame apparatus in which I tried the calcinations by fire, I examined the common ruſt of iron, and flake-white, which is the ruſt of lead, and find them equally converted into non-conductors in the open air.

That this change, in metals particularly, is not owing to, or promoted by, the circumſtance of mere pulverization, is evident, not only becauſe the above-mentioned calces are equally ſtrong electrics when formed into hard maſſes with a thin paſte of flour and water, and afterwards dried, but moſt clearly becauſe the fineſt filings or powders of metals conduct as readily as the intire ſubſtances do. I have glaſs tubes armed as above, and filled with the preparations called powder of tin, *&c.* which conduct as well as a wire when it is not diſcontinued.

But notwithſtanding this change will not ſucceed

in metallic ſubſtances upon mere pulverization, yet it ſeems to follow in moſt other hard bodies.

Having dried a piece of Portland ſtone, I found it conducted perfectly well; but upon powdering, and ſealing it up in one of the tubes with the wire ends, as above, it became a perfect reſiſter, or non-conductor, like the metallic calces.

I have tried the ſame experiment on a variety of other bodies, particularly gum arabic and allum; and have reaſon to believe it will ſucceed in all bodies that can be pulverized in the mortar.

Theſe laſt experiments ſeem to confirm Sir Iſaac Newton's doctrine of a *medium* ſurrounding all bodies, which you have applied to the ſolution of electric phænomena, and are very analogous to the experiments you made with a *chain*, in order to ſhew that the reſiſtance to the paſſage of the electric fluid may be increaſed by increaſing the number of ſurfaces.

Another very extraordinary means of making this change in bodies, which abound in calx or earth, is by fire: not by the intenſe one that calcines, but by a moderate heat; their moſt perfect reſiſtance, or non-conducting property, being when their heat is juſt tolerable to our hands.

I have ſome of the ſame Portland ſtone, wrought into plates nearly as thin as window-glaſs, which I heat to a proper degree, and then coat on both ſides with metal, in order to make the Leyden experiment. When the ſtone is hot enough to ſinge paper, it conducts as perfectly as when cold; but on cooling a little, it begins not to conduct, and affords ſmall ſhocks, which gradually increaſe in ſtrength for about ten minutes; at which time it is about its moſt perfect

fect ſtate, and remains ſo near a quarter of an hour: after that time the ſhocks gradually decreaſe as the ſtone grows cooler, till at laſt they quite ceaſe, and it returns to its conducting ſtate again: but this ſtate appears before the ſtone is quite cold.

Experiments of this kind ſucceed in all bodies abounding in calx or earth, as ſtones, dried clay, wood when rotten or burnt in the fire till the ſurface becomes black.

Among other ſubſtances, I tried a common tobacco-pipe, part of which near the middle I heated to a proper degree, and then applied one end of it to the electrified bar, while the other was held in the hand; and I obſerved that the electric fluid paſſed no farther along the pipe than to the heated part.

To theſe changes brought about with ſudden violence, I muſt add the univerſal change going on in all animal and vegetable ſolids, as they are growing dry. Not only their aſhes reſiſt the paſſage of the electric fluid, but they of themſelves arrive at this ſtate while yet hard and intire; and that much ſooner than one would imagine; for I have bones and hard wood that perfectly reſiſt the paſſage, tho' yet capable of yielding a bright flame, but ſcarce a viſible ſmoke: ſo that beſides an evaporation of their moiſture, but a partial progreſs can have been made in the diſcharge of their ſulphur.

I ſubmit to your judgment, how much this convertibility may contribute to a farther knowlege of the laws of electricity. I am, Sir,

Your moſt humble Servant,

Old Palace-Yard,
March 15, 1759.

Edward Delaval.

XIV. *An*